



# UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE  
United States Patent and Trademark Office  
Address: COMMISSIONER FOR PATENTS  
P.O. Box 1450  
Alexandria, Virginia 22313-1450  
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/003,224	10/26/2001	Paul E. Larson	278.00060120	5031

26813 7590 06/17/2003

MUETING, RAASCH & GEBHARDT, P.A.  
P.O. BOX 581415  
MINNEAPOLIS, MN 55458

EXAMINER

JOHNSTON, PHILLIP A

ART UNIT PAPER NUMBER

2881

DATE MAILED: 06/17/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

**Office Action Summary**

Application No.

10/003,224

Applicant(s)

LARSON ET AL.

Examiner

Phillip A Johnston

Art Unit

2881

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☐ Responsive to communication(s) filed on \_\_\_\_.
- 2a) ☒ This action is FINAL. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 1-50 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-50 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 18 July 2002 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on \_\_\_\_ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

**Priority under 35 U.S.C. §§ 119 and 120**

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☒ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

**Attachment(s)**

- 1) ☐ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) \_\_\_\_.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). \_\_\_\_.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: \_\_\_\_\_.

*Detailed Action*

*Examiners Response to Arguments*

1. 3. Claims 1-50 as amended are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 6,447,891 to Veerasamy, in view of Miyawaki U.S. Patent No. 5,543,648.

Regarding Claims 1-5, 22 and 35, Veerasamy (891) discloses a method for XPS analysis of thin film samples approximately 750 Å<sup>0</sup> thick, wherein, high energy x-ray photons (monochromatic) impinge on the surface of layer 9. Electrons from the surface are ejected and their energy and number (count) measured. With these measurements, one can deduce the electron binding energy. From the binding energy, one can determine three things: elemental fingerprinting, relative quantity of elements, and the chemical state of the elements (i.e. how they are bonding). Components used in the XPS analysis include the monochromatic x-ray source, an electron energy analyzer, and electron flood gun to prevent samples from charging up, and an ion source used to clean and depth profile. Photoelectrons are collected from the entire XPS field simultaneously, and using a combination of lenses before and after the energy analyzer are energy filtered and brought to a channel plate. The result is parallel imaging in real time images. See Column 18, line 64-67, and Column 19, line 1-14.

In addition Veerasamy (891) teaches that the ion beam source functions to deposit a DLC inclusive layer 9 on substrate 1 over layers 2-7 so as to be in contact with layer 7 (e.g., layer 7 may be of silicon nitride to improve bonding between layers 7 and 9). See Column 16, line 5-8.

It is implied herein that a computing apparatus, as recited in Claims 46-50 was utilized to perform the XPS analysis and produce the real time images in accordance with Veerasamy (891) above.

Regarding Claims 11,15,19,20,26 and 34, Veerasamy (891) discloses in FIG. 8 the % concentration, with regard to C, O and Si for layers 9 and 10, while FIG. 9 shows the % concentration, with regard to C, O and Si for layer 11, throughout the respective thicknesses of these layers. X-ray Photoelectron Spectroscopy (XPS)/Electron Spectroscopy for Chemical Analysis (ESCA) was used to develop these graphs from sample products. See Column 20, line 10-16.

Although Veerasamy (891), did not disclose the measurement of % concentration of Nitrogen, as recited in Claims 11,15,19,20,26 and 34; however, since similar elements such as Carbon and Oxygen were measured, it would have been obvious to one of ordinary skill in the art that the measurement of % concentration of Nitrogen could have been included in the XPS analysis in accordance with Veerasamy (891), if so desired.

Regarding Claims 6-8, 29-31 and 36-38, Veerasamy (891) also teaches that

Information on the surface is obtained from a lateral dimension as large as 1 mm diameter and from a depth of 0-10  $\mu\text{m}$ . To acquire information from slightly greater depths, angle resolved measurements can be made. See Column 20, line 30-33.

Regarding Claims 9,10,32,33,39-41,44 and 45, Veerasamy (891) as applied above disclosed an ion source to depth profile, wherein elemental concentration was measured as a function of material removal from the surface; i.e. sputter time vs. depth, as shown in Figures 8 and 9. Veerasamy (891) further discloses FIG. 8 illustrates the % concentration of C, O and Si throughout the thicknesses of DLC inclusive layers 9 and 10 of protective coating system 15 of the FIG. 2(a) embodiment. Cycle number 1 is at the outer surface of layer 10, while cycle number 19 is believed to be within the underlying glass substrate 1 (remember, layers 9-10 were deposited directly on a glass substrate absent layers 2-7 for purposes of this test). Thus, it is believed that the interface between glass substrate 1 and underlying DLC inclusive layer 9 is at about cycle number 15 where the C % begins to significantly decrease. The "time" and "depth" columns refers to depth into layers 10, 9 from the exterior surface of layer 10 as compared to the depth into a conventional  $\text{SiO}_2$  that would be achieved over the same time period. Thus, the angstrom depth illustrated in FIG. 8 is not the actual depth into layers 10, 9, but instead is how deep into a  $\text{SiO}_2$  layer the sputtering would reach over the corresponding time. See Column 20, line 34-52.

Veerasamy (891) further teaches that, the optimal ion energy window for the majority of layers 9, 10 is from about,100-1,000 eV, (preferably from about 100-400

eV) per carbon ion. At these energies, the carbon in the resulting layers 9 and/or 10 emulates diamond. However, compressive stresses can develop in ta-C when being deposited at 100-150 eV. Such stress can reach as high as 10 GPa and can potentially cause delamination from many substrates. It has been found that these stresses can be controlled and decreased by using an ion energy during the deposition process in a range of from about 200-1,000 eV. Also, at particle energies (carbon energies) of several hundred eV, a considerable material transport can take place over several atomic distances. This is caused by the penetration of fast ions and neutrals as well as by the recoil displacement of struck atoms. At sufficiently high particle energies and impact rates, there is an enhanced diffusion of the thermally agitated atoms near the film surface that occurs via the continuously produced vacancies. See Column 16, line 39-61.

Although Veerasamy (891) does not disclose the use of a <500ev ion energy beam for depth profiling, as recited in Claims 9,10,32,33,39-41,44 and 45, it would have been obvious to one of ordinary skill in the art that Veerasamys'(891) use of <500 ev ion beams for coating deposition, could also be used to optimize material removal in XPS depth profiling, if so desired.

Regarding Claims 17,21,and 28, Veerasamy (891) disclosed an Ion beam source 25, which includes gas/power inlet 26, anode 27, grounded cathode magnet portion 28, magnet poles 29, and insulators 30. A 3 kV DC power supply may be used for source 25 in some embodiments. Linear source ion deposition allows for

substantially uniform deposition of layers 9 and 10 as to thickness and stoichiometry.

The ion beam emanating from the slit is approximately uniform in the longitudinal direction and has a Gaussian profile in the transverse direction. See Column 14, line 24-29, and Column 15, line 5-7.

4. Claims 12-14, 16, 18, 23-25, 27, 42 and 43, are rejected under 35 U.S.C. 103(a) as being unpatentable over Veerasamy (891), as applied above to Claims 1-11, 15, 17, 19-22, 28-41, and 44-50, in view of Miyawaki (648).

Miyawaki (648) discloses a Semiconductor device with nitrided silicon dioxide films, wherein to attain a degree of integration of 256M bit to 1 G bit level in DRAM, it is necessary that an insulating layer formed on the surface of a semiconductor has a very small thickness such as 1.0 to 1.5 nm. Column 1, line 36-40. In addition, the degree of hydrogenation-treated state on the surface of substrate (S) was evaluated by determining the thickness of the spontaneously oxidized film formed on the surface by an XPS (X-ray Photoelectron Spectroscopy) apparatus. See Column 5, line 1-5.

Miyawaki (648) also disclosed an integrated circuit device of 200,000 gates of MOS-FETs, which was prepared with monocrystalline Si thin film. The gate oxide films of MOS-FETs were formed to a thickness of 100 Å<sup>0</sup> by dry oxidation at 1,000.degree. C. The dielectric strength of the thus formed oxide film was such a high value as 12 MV/cm or higher at all the MOS-FETs. See Column 6, line 23-49. The wafer processed up to the step as shown in FIG. 3B was dipped in a mixture of platinum-hydrogen peroxide solution, whereby a thin oxide film having a thickness of ten Å<sup>0</sup> on

Art Unit: 2881

the wafer surface was formed. Then, the wafer was heated in an N<sub>2</sub> atmosphere at 500 degree C to increase the density of the thin oxide film. By this treatment, an oxide film 17 having a very uniform thickness and a good quality could be formed at such a low temperature as 500 degree C. See Column 10, line 10-18.

Miyawaki (648) further teaches in FIG. 6, that numeral 18 is BPSG (boron-phosphorus doped glass), and 19 is an SiO<sub>x</sub>N<sub>1-x</sub> film. By providing a layer composed of a material having distinguished reflow characteristics at the bonding interface, as compared with SiO<sub>2</sub>, the bonding became more complete and the uniformity was improved. In this example, a combination of BPSG with the SiON film has been explained, but NSG (non-doped glass) or PSG having better reflow characteristics than those of BPSG or thermally oxidized SiO<sub>2</sub> film, which is formed by CVD can be provided alone, and besides SiON, it is possible to use AlN, SiN, or their combinations. See Column 10, line 29-45.

Therefore, it would have been obvious to one of ordinary skill in the art that the Veerasamy (891) method and apparatus for thin film characterization can be modified for use with Miyawaki's (648) gate dielectric film process, to further extend the utilization of XPS depth profiling to the nitrided silicon dioxide films used in semiconductor manufacturing processes.

3. Applicant's arguments filed 4-15-2003 have been fully considered but they are not persuasive.

Argument 1



Applicant states that "The cited references do not describe, teach or suggest all the claim limitations. For example, the cited references fail to describe, teach or suggest the calibration information as set forth in the claims, and as such, also the use of such calibration information in the determination of at least one characteristic of a sample to be characterized.

Veerasamy et al. simply teaches using a low energy electron flood gun to reduce surface electrical charging in an XPS process to analyze the layer formed by the coating system. The XPS analysis performed is conventional XPS processing and in no manner describes calibration information and use thereof as presented in the pending claims. For example, Veerasamy et al. does not describe calibration information representative of surface spectrum measurements for a plurality of samples correlated with depth profile information for the plurality of samples (i.e., the depth profile information of each sample of the plurality of samples provided using surface spectrum measurements corresponding to one or more progressively deeper depths of each sample). Therefore, such claimed calibration information is not -used *in* Veerasamy et al. to determine at least one characteristic of a sample to be characterized."

The applicant is respectfully directed to page 29, line 15-24 of applicant's Specification, in order to define the terms "surface spectrum measurements", and "calibration information" above, which states; As used herein, calibration information refers to any relational information between non-invasive surface spectrum measurements of a sample and information characterizing or for use in characterizing

a sample; e.g., thin film. For example, such calibration information may take the form of concentration information over a depth of the sample as it relates to non-invasive surface spectrum measurements.

Also page 28, line 9-30, which states; Figure 9 shows a general flow diagram of a non-invasive characterization method 300 according to the present invention which uses invasive depth profiling, such as depth profiling using the methods and systems described above, to generate calibration information (block 302). The calibration information can then be used in conjunction with surface spectrum measurements of a sample to non-invasively determine one or more characteristics of the sample (block 304). Surface spectrum measurements are collected for each sample (block 342). Such surface spectrum measurements are non-invasive measurements generated non-invasively before removal of material from the sample, e.g., at the beginning of depth profiling or before depth profiling is performed. For example, an x-ray source irradiates the sample with x-rays resulting in the escape of photoelectrons therefrom.

Regarding the calibration information disclosed in Veerasamy (891), the applicant is respectfully directed to Veerasamy (891), Column 19, line 15-19, which states; Components used in the XPS analysis include the monochromatic x-ray source, an electron energy analyzer, and electron flood gun to prevent samples from charging up, and an ion source used to clean and depth profile. Photoelectrons are collected from the entire XPS field simultaneously, and using a combination of lenses before and after the energy analyzer are energy filtered and brought to a channel

plate. The result is parallel imaging in real time images. Sample Nos. 1-3 of DLC inclusive layer 9 were made and analyzed using XPS, which indicated that the samples included the following chemical elements by atomic percentage (H was excluded from the chart below).

Sample No.	C	O	Si	F
1	54.6%	23.7%	20.5%	1.2%
2	45.7%	21.7%	32.7%	0%
3	59.5%	22.7%	17.8%	0%

Also Column 20, line 34-49, which states; FIG. 8 illustrates the makeup with regard to C, O and Si throughout the thicknesses of DLC inclusive layers 9 and 10 of protective coating system 15 of the FIG. 2(a) embodiment (i.e., no FAS layer was on layers 9 and 10 when this data was measured, so as to resemble FIG. 2(b)). Cycle number 1 is at the outer surface of layer 10, while cycle number 19 is believed to be within the underlying glass substrate 1 (remember, layers 9-10 were deposited directly on a glass substrate absent layers 2-7 for purposes of this test). Thus, it is believed that the interface between glass substrate 1 and underlying DLC inclusive layer 9 is at about cycle number 15 where the C % begins to significantly decrease. The "time" and "depth" columns refers to depth into layers 10, 9 from the exterior surface of layer

10 as compared to the depth into a conventional SiO<sub>2</sub> that would be achieved over the same time period.

The examiner has interpreted from the applicants specification and the Veerasamy (891) references above that the percent concentration information obtained over a depth on a plurality of samples, in accordance with Veerasamy (891) is equivalent to obtaining "calibration information representative of surface spectrum measurements for a plurality of samples correlated with depth profile information for the plurality of samples".

### ***Conclusion***

4. Applicant's arguments filed 4-15-2003 have been fully considered but they are not persuasive. Arguments are moot in view of new grounds for rejection.

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of

Art Unit: 2881

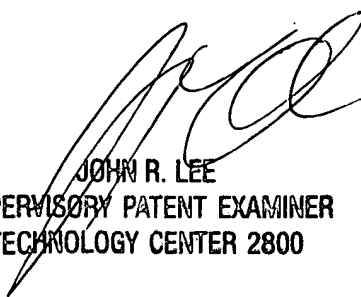
the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

5. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Phillip A Johnston whose telephone number is 305 7022. The examiner can normally be reached on 7:30 to 4:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, John R Lee can be reached on 703 308 4116. The fax phone numbers for the organization where this application or proceeding is assigned are 703 872 9318 for regular communications and 703 872 9319 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703 308 0956.

PJ  
June 5, 2003



JOHN R. LEE  
SUPERVISORY PATENT EXAMINER  
TECHNOLOGY CENTER 2800